



Systematic Interaction between Industry and University is the Pre-Condition of Science-based Economy

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Abstract. The goal of writing this paper is to study the necessity of collaboration between university and industry as the pre-condition of science-based economy and how this collaboration is established, and this was conducted using library method. The results of the study showed that the main barrier on the way of interaction between industry and university is the structural problems of the state economy and as long as the structure of the industrial sector, higher education and as a result the state economy does not improve and the existing gap between research (university) and production (industry) is not filled, research does not result in production.

Keywords: University, Industry, Collaboration, Entrepreneurship

1. INTRODUCTION

The collaboration between industry and university is a process that is formed during time and emanates from national needs and necessities in the historical periods, alignments and applied goals related to it. It is also evident that self-reliance of the society and the economic and social development of Iran require research-centered industrial development which is achievable through interaction between university and industry (Sheikhi, 2003). Considering the rapid developments of industry, technology and products, the industries require two-way and close cooperation with the universities to achieve competitive advantage and increase productivity (Perkmann, 2011). The universities also need to cooperate with industry to flourish and develop (Cao et al, 2009). Establishment of effective collaboration between university and industry improves joint interaction and activities between these two institutions and increases the quality and appropriateness of the academic educational courses in the university, he industrial requirements and as a result the scientific and practical abilities of the students to improve the grounds for innovation and progress in organizations and society, thus if this connection is formed according to wrong collaborations, the society will not be able to achieve

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its demands in line with development and progress (Faez, 124, 2010, 97). A look at the history of collaborations between industry and university in Iran shows that firstly formation of this collaboration during time was not based principally and lacked a fundamental ground. Secondly the concept, direction and alignment of this collaboration were not targeted and specified correctly. While the experience of the countries where the bilateral collaboration between industry and university exists strongly shows that the collaboration was founded correctly from the beginning and has developed in a structured fashion (Shafiei, 32, 2003, 21). In our country different actions have been taken so far to increase the cooperation between university and industry, but despite the made efforts, the results have not been sufficiently satisfactory. During recent years, a new model under the title of coordination societies of science and industry were formed to establish and develop the collaboration between university and industry throughout the country.

2. IMPORTANCE AND NECESSITY OF THE ISSUE

The Iranian society as a developing society needs to grow and develop regularly and symmetrically so that it could provide a better life together with more welfare and peace for its members. For this purpose, it is necessary for the different social regimes and institutions to have a dynamic coordination and collaboration in order to reach this goal and to pave the ground for reaching balanced development through their reciprocal collaborations. University is one of the main scientific and cultural institutions of a society which is responsible for education and growth of the youth of every society and should show a widespread effort to establish and develop the scientific experts of the society. They are the experts who should carry the main load of development and progress of Iran of today. On the other hand, every society needs production and re-production of goods, equipment and different tools and the international experience has proved that every country should have a higher background of production if it wants to access welfare and security and this production backup requires efficient and advanced industries and the industries that lead to economic growth of that society. What the wisdom and logic say and the experience of the advanced industrial countries confirm is the necessity of an ongoing and firm collaboration between these two social institutions in every society. It seems that we can only move toward industrial development and progress if we do not ignore the reciprocal collaboration between these two institutions. The industries of the country will only access actual growth and development if they follow the specialist and inventive plans of the students, graduates of universities and elites seriously, and the universities will only develop and become dynamic when they use their knowledge and expertise in industrial products of industries, take steps on the path of research to respond to the needs of industries and to take serious steps to meet the requirements of the society. Universities are in principle the centers to produce science and this science should be used somewhere and one of the most necessary and important places that require this science and knowledge is the industries.

3. REVIEW OF THE THEORETICAL GROUNDS OF RESEARCH

3.1. Collaboration between university and industry in the world

Nowadays all the structures including the structures of science, technology and industry require to have deep insight and be realistic, comprehensive and generous and the ones active in industries should accept that they can only digest and absorb technology correctly beside the university. The academia should believe that they need close cooperation with industries (Shafiei, 2005). In this direction, university and industry try to do some of their scientific activities jointly and collaboratively. However bilateral cooperation of these two institutions consists of some activities that they cannot handle those activities by themselves (Shafiei, 2004). On the eve of the third millennium university can play an important and vital role as the most important part of the state educational system to develop scientifically. Regular and responsible performance of the university can also provide the society with the general security in addition to assisting the state industrial development. When the universities spend most of their time for scientific activities and merely theoretical ones, the industries are mainly involved in practical and production activities (Meredith et al, 2008). The produced knowledge in the university can be considered as a competitive advantage for the industry (Salter and Bruneel, 2009). Brown showed in his study in the UK that the economic successes of that country depend too much on scientific and university researches (Brown, 1991).

The university can also use financial resources and equipment of industries and the students can spend their apprenticeship periods in the industries to get familiar with industrial environment and face the existing daily challenges (Rothman, 2007). One of the other connecting factors among universities and industries is the attempt to do research, to develop and to transfer the modern technology of the world. Technology transfer, research and development are the most important factors motivating the world economy of today (Manning et al, 2008).

3.1.1. Models to analyze interaction between science and industry in general and university and economic firms in particular

* Linear model of science push

According to this model, innovation process starts from the research question of a certain course in the university, goes through applied studies and leads to development of product in the firm.

* Linear reverse model or markets pull

According to this model, innovation process starts from one issue in the firm or bigger system, a solution is sought and it leads to a new research and development plan in the university or firm.

* Interactive model of pull-push

Where the non-linear movement is created from science push to market pull and vice versa.

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* **National innovation system**

According to this model innovative ideas originate from very different resources and flow. Innovation needs effective interaction among economic operators including companies, general labs, scientific institutions and consumers as well as feedbacks among science, engineering, product development, manufacturing and marketing.

* **Tripartite model of university, industry and government or Triple Helix**

This model was introduced and developed in early 12th century by Leydesdorff and Etzkowitz (Leydesdorff, 1997). In this model the issue of innovation and technology development is looked at from an evolutionary perspective. The model of tripartite model of university, industry and government or triple helix has three versions that could be shown as follows: TH1, TH2 and TH3 (Entezari, 2006, 2003, 159).

3.1.2. Plans to establish collaboration with industry

* **Internship course**

In this course tripartite short-term collaboration is generally established among students, academic staff and experts of industrial sector. In this course, the students resolve the problems of the industrial units after getting familiar with these problems within the framework of teams with several courses and alignments.

* **Externship course**

This course allows the students to observe and study different professions closely and to select their future jobs with a more open mind. The length of externship course differs from one day to one month. The students are not paid salaries in this course and in addition the students should also meet the costs of their activities themselves.

* **Practicum course**

It is considered as a part of a university class when the student is active in one of the parts of the industrial sector relevant to that unit temporarily. The goal of this course is for the students to see in the professional world and in practice what is expressed about an issue in the faculty in order to have a better and deeper understanding of the mentioned theories.

* **Co-operative education**

This course is planned in a way for the student to spend the last five semesters of his study on full time basis in industry to gain experience. These semesters are called working semesters (Nourani, 56, 2002).

Here a glance at the successful experiences of several countries to establish a suitable collaboration between these two institutions will help the discussion.

***Japan**

In 1960 the ascending growth of industries led to the establishment of research and development units independent from universities. But the distance between industry and university was the reason for failure of these centers. The first successful experience between industry and university was invention of electron telescope that led to the remarkable growth of molecular Physics. Since then the government's direct interference and support of industry have established the link in different areas including consultation, contractual researches, joint researches, donated laboratories, industrial assistance to research budget of universities and link with the industry (Afshari, 76, 1997, 57). Japan is currently one of the advanced countries of the world and its development model was precisely taken into consideration by different Asian countries, particularly Asian tigers. From historical point of view, Japan is the only Asian country that evaded from colonial power and or dependence on western capitalism or the US and managed to have an independent national development (Baran, 1979).

***South Korea**

In 1960 it created the development model according to the industrial planning and strategies of technological advancement. 1960s could be considered as the step used to jump for industrialization. This decade was the time to emphasize on the entry of advanced technologies. 1970s could be considered as the industrial growth step with emphasis on development of some industries such as car manufacturing, chemical, ship manufacturing and electronics. Development of long-term applied trainings created the necessary talents and abilities to adopt and develop the existing technologies at that time together with the imported technologies.

In order to put the above policies and strategies in action, Korea took the following steps in the first decade:

A. In 1966, KIST, the Korean Institute of Science and Technique was established as a multi-discipline industrial research institute.

B. In 1967, MOST, Ministry of Science and Technology of Korea was established as the central organization with the responsibility to plan and coordinate the technical sciences beside the other governmental organizations.

C. In 1971, KAIS, Korean Supreme Institute of Science was established as the higher education institute of applied and engineering sciences.

D. Many technical and vocational schools and institutes were established to meet the requirement for skillful human workforce and technicians.

E. Standard Research Institute of Korea was established to support and supervise the quality control in the industries.

F. The house to exchange information for industrial researches was also established (Taheri, 101-1251375).

***Taiwan**

Due to the inefficiency of the state industrial structure, the government established 'Technological Studies Institute' in 1973 to accelerate promoting the sciences technologically. This institute was acting as a link between development researches in universities and governmental and private institutions and industries. Establishment of a scientific-industrial park 80 kilometers away from southwest, Taipei, China was also a good example of government's activities and the link between industry and university in that country (Afshari, 65, 1997). Currently the above-mentioned developments raise Taiwan as one of the Asian tigers in the context of macro industrial strategies so that the industrial capital and industrial production are of special importance in that country.

3.2. Collaboration between university and industry in Iran

Historical evidences in our country in connection with practical science have also a long history in Iran. The evidences indicate that in ancient time, only the sciences whose efficiency was proven in the society were paid attention to. By appearance of Islam and the great respect that Islam pays to science and scientists, scientific centers grew in Iran within a vaster and more expert framework and were established under different titles such as 'Daro-shafaha' [hospitals], 'Beit-ol-Advieha' [drugstores], 'Darol-elmha' [universities] and 'Nezamieha' [law courts] that played a prominent share in production of knowledge (Ministry of Science, Research and Technology, 13, 2001). The modern form of higher education in Iran was established to respond to the growing needs of the society called 'Darolfonoon' in 1949, 20 years before the similar university was established in Tokyo and 3 years before the similar university was established in Istanbul. This university responded to the military, medical and engineering needs in Iran and more interesting than all it started its activity by establishment of factories making candles, crystals, paper, thread-weaving, etc. and those factories as the factories affiliated to Darolfonoon were run by the graduates of this university (same source, 19-23). This trend led to the expansion of other higher education centers such as Tehran University in 1934 and Ministry of Science and Higher Education in 1967. But gradually by superiority of degree-oriented mentality as well as lack of the required knowledge of the actual needs of the society, the gap between higher education institutes and working environment was deepened and its consequences still continue.

The conducted review on the trend of collaboration between industry and university indicates that university and industry are and were connected traditionally within the non-official framework, while they are sometimes organized (with each other). What is called active collaboration with environment when it comes to universities is to encourage and pursue official cooperation between university and industry and to provide the language to understand better to find out about bilateral interest, promotion of professionalism and encouragement of entrepreneurship both in the university and the society in general and this has to be pursued knowingly and regularly. Nowadays, in most countries the universities generally face increased

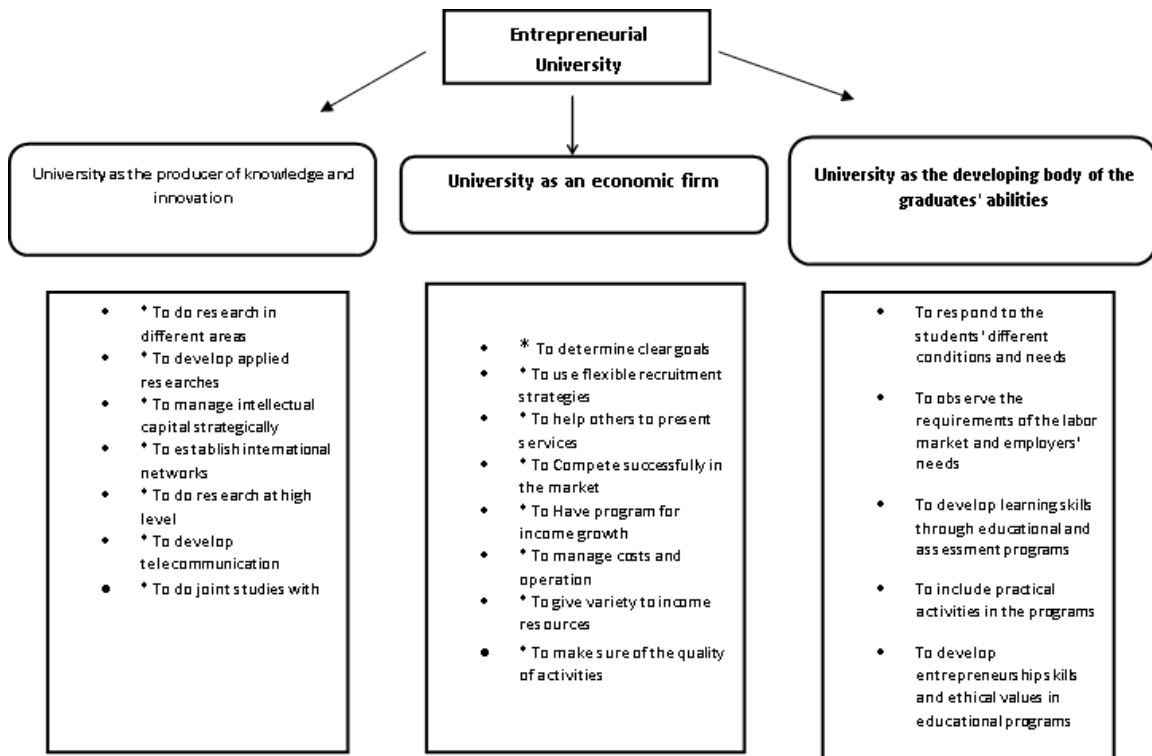
public expectations and particularly their governments' expectations. They have to adopt more tasks on their agenda while requesting lower budget from their government.

4. IMPORTANT CHARACTERISTICS OF SUCCESS OF UNIVERSITIES TO MOVE TOWARD ENTREPRENEURIAL UNIVERSITIES

1. Establishment and reinforcement of capable management teams
2. Adding variety to new financing resources
3. Emphasizing on scientific independence of academic members together with development of inter-disciplinary educational groups.
4. Expanding the activities of universities and the environment
5. Creating an integrated culture

Support for the activities based on entrepreneurship is the same five elements or specifications that when used together by the universities will make these universities distinct from other universities (Burton, 1998)

Table 1. Dimensions of Entrepreneurial University (Burton, 1998)



As it is noticed in table 1, Entrepreneurial University is the university that in addition to having close collaboration with its environment does not neglect the two main functions of 'university as a producer of knowledge and innovation' from research point of view and 'university as a developer of graduates' abilities' from educational point of view to identify and earn new financial resources within the framework of university as an economic firm.

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University can continue its activities based on a mixture of them as a dynamic and entrepreneurial university. Beside the first ring of education and the second ring of education, there is a third ring which is considered as presenting services to the society. This is the dimension that plays the critical role of university in connection with the beneficiaries' expectations generally and forms a new source to finance particularly. It has to find its systematic place in the organizational structure of the university and to be promoted. University achievement to play the assigned roles in one hand requires being responsive to special environment and on the other hand requires considering the existing factors in the public considering attention to international considerations.

4.1. Joint interests of collaboration between university and industry

Absence of a mutual understanding language between university and industry has made them ignore their capacities, while the studies showed that they have interests in being together. Each of these has high incentives on its own to establish collaboration (Nourani, 2009). Chart 1 shows the effective motivational factors on the collaboration between university and industry.

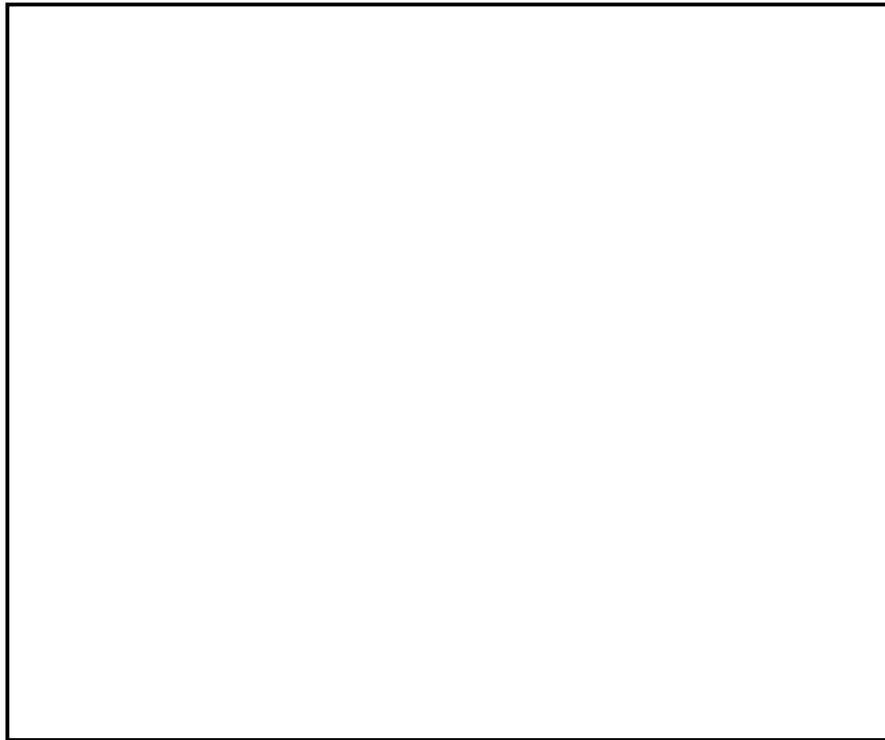


Chart 1. Motivational factors effective on relation between university and industry.

Industry also has benefit in having engagement with university and research and scientific centers and in this way can add to its abilities and achieve the required competitive advantage (the same) in the highly competitive world of today and the very dynamic and variable environment around it. Figure 2 also shows the effective motivational factors on collaboration between industry and university.

- Possibility to access research facilities and required expertise
- To Use educational facilities
- To access required consultations
- To obtain required information and use unique solutions
- To acquire dignity and increase positive impression of oneself
- To improve public relations and good social relations
- To keep oneself up-to-date with new scientific, technological advancements and development of skill levels
- To develop research morale in professional and action areas
- To empower development of new products, to access new markets and to develop skill levels
- To reduce environmental uncertainty
- To respond to the expectations of officials, political activists and customers, etc.

Chart 2. Motivational factors effective on collaboration between university and industry.

Considering the above chart, it is noticed that when the industry is up-to-date with new scientific and technological achievements, uses educational facilities, has access to expert forces and research facilities, prepares ground for research and development culture in the area of profession and action, acquires prestige and increases the positive image of industry in the society, all these work in favor and industrial incentives of the industries to cooperate with universities. Materialization of these indicates achieving advantages that the industry needs them desperately under the current conditions (Nourani, 2002).

4.2. Obstacles on the way of collaboration between university and industry

Despite the bilateral interests to establish collaboration between university and industry, the findings of the studies indicate that there are problems and obstacles on the way of such collaboration. Table 1 refers to some of the most important obstacles on the way of collaboration between industry and university.

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Table 2. Problems and obstacles on the way of collaboration between university and industry.

Subject	University	Industry
-Different goals	-To find reasons, to discover scientifically, to develop border of knowledge	-Emphasis on clear and practical solutions, saving time and costs
-Different management structures	-Inflexible, bureaucratic	-Flexible (particularly in private sector)
-Different time frameworks	-Long-term and mid-term with emphasis on precision and authenticity	-Short-term with emphasis on speed
-Different values and cultures	-Knowledge-oriented	-Action-oriented and profit-oriented
-To have different attitude toward each other	-Directors' concentration on routine action and their lack of attention to development of knowledge	-Finding academia unprofessional and their lack of attention to action and application of theories

As it is noticed, there are differences among objectives, management structure, and expected time framework, governing culture and expectations over university, industry and more importantly the attitude of the academia and industrial directors toward each other.

5.

CONCLUSION

Assistance to improve the quality of life of people and to remove the basic needs of the industrial sector and services to establish competitive advantage and to promote ability of exports require using modern knowledge and technology and having effective collaboration between university and industry. What is important for Iran and other developing countries is to review the experiences of the industrially developed countries and to adopt models according to the cultural environment and industrial and scientific capacity of the country. Unfortunately in our country some developments in the area of industry and application of models from developed countries happen from time to time without paying attention to the cultural environment and scientific and expert capacity of the country and such developments will face failure and are put aside after a while without any outcome. Thus it could be concluded that the main problem in interaction between industry and university is the structural problems of the state economy and as long as the structure of the industrial sector, higher education, its consequences and state economy do not improve and the gap existing between research (university) and production (industry) is not filled, research will not result in production or in other words, university and industry go their own ways and there will not be an integrated and organic collaboration between them, and if there is going to be a growth, the growth will be external, temporary and minimal. In our country, Iran, there has always been concern about the

collaboration between the two institutions of universities and industries. After the revolution and particularly in the recent years some steps have been taken to promote this collaboration and there is hope that this link will expand.

6. SUGGESTED SOLUTIONS

1. To increase the collaboration between university and industry by making university studies applied and support the industries for these studies and in general to consider investment in three sectors of research, i.e., fundamental, applied and development.
2. To promote the scientific degree of professors according to their cooperation with industry.
3. To make universities industrial centers (affiliation of each university to special industry maintaining and presenting basic subjects).
4. To establish the required conditions and to attract employment of university graduates to industry and to create suitable and easy grounds for the graduates to continue their studies at the universities.
5. To establish joint research centers of university and industry.
6. To develop educational courses required by industry in universities and to create and establish relevant schools to industrial education as well as short-term industrial courses and education of technicians.

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